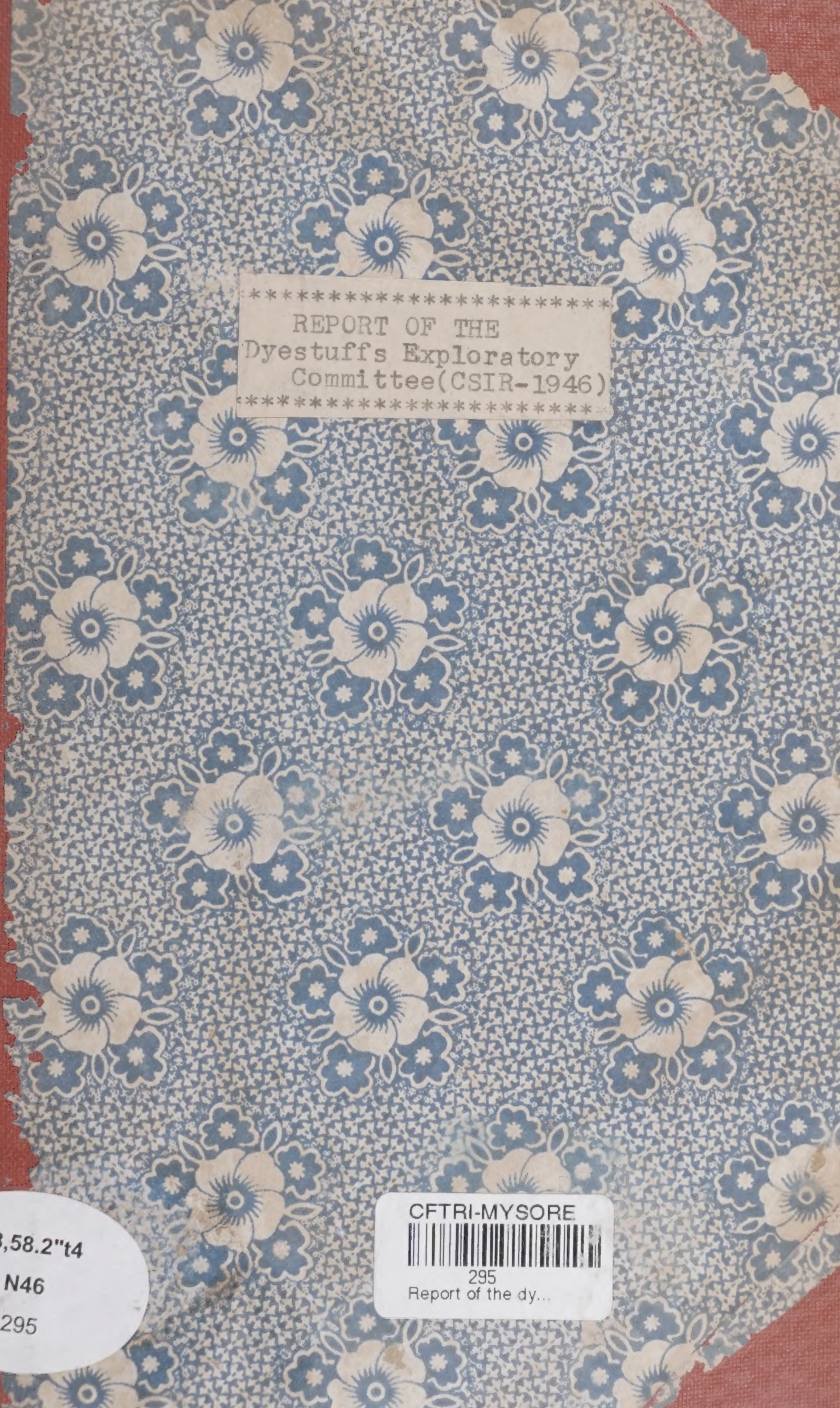

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REPORT OF THE
Dyestuffs Exploratory
Committee(CSIR-1946)
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Report

of the

Dyestuffs Exploratory Committee

APPENDICES

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APPENDIX I

STATEMENT SHOWING THE QUANTITY AND VALUE OF THE DIFFERENT KINDS OF "DYES OBTAINED FROM COAL TAR" IMPORTED INTO BRITISH INDIA BY SEA FROM ABROAD DURING EACH OF THE FIVE YEARS 1937-38 TO 1941-42.

—	1937–38		1938–39		1939-40		1940–41		1941–42	
	Quantity (Lbs.)	Value (Rs.)	Quantity (Lbs.)	Value (Rs.)	Quantity (Lbs.)	Value (Rs.)	Quantity (Lbs.)	Value (Rs.)	Quantity (Lbs.)	Value (Rs.)
Dyes obtained from coal tar—										
(a) Alizarine—										
(i) Dry—										
Not exceeding 40%	4,100	6,939	580	1,284	..	..	..	..	320	2,885
Exceeding 40%	8,660	24,584	1,970	5,527	2,833	1,196	15,352	99,979	22,324	2,04,277
(ii) Moist—										
Not exceeding 16%	181,552	85,471	64,736	28,385	39,584	2,736	3,106	2,816	6,620	8,784
Over 16% but not exceeding 20%	1,759,624	9,47,887	558,374	2,88,989	604,306	41,363	958,082	11,46,626	1,275,924	21,45,722
Exceeding 20%	305,648	3,12,708	248,207	2,44,544	137,819	14,331	278,916	5,05,949	115,636	3,34,281
(b) Congo Red	2,106,595	11,37,004	474,384	2,53,811	563,102	55,095	1,091,081	17,04,364	798,567	14,84,448
(c) Coupling Dyes of Naphthol Group—										
Naphthols	1,358,646	30,60,510	915,739	23,40,138	857,454	2,34,621	663,320	38,87,031	399,360	31,99,392
Rapid fast colours (Rapid salts)	87,758	5,03,773	147,053	8,96,026	126,364	7,580	22,889	2,11,646	38,024	4,01,864
Bases	777,051	16,70,460	495,366	10,30,854	333,526	8,832	452,831	27,60,313	584,225	43,65,480
Other Salts	1,174,797	18,38,060	1,014,712	17,27,591	855,069	13,921	298,213	11,69,886	358,314	19,12,758
(d) Vats—										
Indigo	904,909	12,67,630	676,925	9,74,536	698,359	12,277	577,691	15,24,088	544,387	14,86,249
Carbazole Blue	145,433	3,24,163	84,615	2,03,708	64,285	1,955	92,035	4,63,444	39,965	2,22,365
Other sorts—										
Paste	176,703	7,65,263	156,897	6,91,487	165,713	8,026	353,016	21,16,095	464,003	31,60,129
Powder	784,929	1,21,35,205	814,187	1,11,08,021	631,642	98,072	521,417	131,42,573	461,394	1,32,73,734
(e) Sulphur Black	4,759,338	9,81,366	2,638,184	5,75,816	3,798,823	17,823	3,865,047	35,35,025	3,061,924	37,18,821
(f) Metanil Yellow	814,292	6,63,513	202,793	1,94,395	211,163	2,738	187,835	4,00,843	132,358	3,41,884
(g) Auramine of concentration of 13% and less	..	..	..	..	78	1	..	..	..	..
(h) Rhodamines (certhamines) of concentration of 15% and less	..	..	..	..	..	..	..	..	200	750
(i) Aniline Salts	373,889	1,34,507	243,743	60,737	238,200	1,09,583	210,463	2,35,715	208,783	2,59,916
(j) Others	5,164,421	84,10,323	3,284,733	56,85,527	3,481,604	77,80,062	3,838,890	126,42,975	3,214,747	1,38,84,934
Total of Dyes obtained from Coal Tar.	20,868,345	3,42,75,636	12,023,198	2,63,31,336	12,829,996	2,87,06,125	13,330,184	4,55,49,368	11,726,675	5,04,08,673

APPENDIX II

CONSUMPTION OF DYES DIVIDED INTO ABOUT 100 GROUPS.

GROUP.	Sales per Annum.	Group Total.
	Lbs.	Lbs.
BASICS.		
Auramines	86,200	
Browns	28,200	
Magentas	65,100	
Rhodamines	71,300	
Violets	69,800	
Blues (General)	41,600	
Victoria Blues	17,500	
Greens	1,26,400	
Various	10,300	5,16,400
ACIDS		
Yellow & Tartrazines	9,900	
Metanil Yellow	1,68,000	
Orange	94,200	
Red	29,200	
Wool Scarlet	62,400	
Blues	18,200	
Patent Blues	16,100	
Black & Nigrosines	49,700	
Various	12,200	4,59,900
CHROMRES	44,200	44,200
OTHER ALIZARINES	8,800	8,800
ALIZARINE PASTE		
Alizarine Red 16% Paste	1,88,700	
Alizarine Red 20% Thin Paste	8,60,200	
Alizarine Red 20% Thick Paste	5,74,400	
Alizarine Red 40% Thin Paste	1,27,900	
Alizarine Red 40% Thick Paste	49,700	18,00,900
ALIZARINE POWDER AND LUMPS.		
Alizarine Red above 40% Lumps	7,200	
Alizarine 100% Powder	3,800	11,000
DIRECTS.		
Orange	94,700	
Yellow	21,600	
Chrysophenine	1,33,200	
Browns	1,09,400	
Benzopurpurine	61,000	
Fast Pinks	28,600	
Fast to Acid Red	86,500	
Red (General)	61,800	
Congo Red	11,98,000	
Violets	39,400	
Blues	1,08,300	
Greens	87,600	
Grey & Blacks	1,96,700	
Blue Black	1,18,100	23,44,900
Carried forward		51,86,100

GROUP.	Sales per Annum.	Group Total.
	Lbs.	Lbs.
Brought forward		51,86,100
SULPHUR.		
Yellows	54,100	
Orange & Violets	6,100	
Browns	41,500	
Blues	1,23,200	
Greens	65,000	
Blacks	31,96,600	
Indo Carbon CL & CLG Conc.	63,800	
		35,50,300
INDIGO.		
Indigo 60% Grains	6,75,200	
Indigo Carmine	400	
		6,75,600
VAT PASTE		
Yellow	2,100	
Orange	200	
Brown	43,800	
Red	4,500	
Violet	66,800	
Blue	28,000	
Olive & Green	33,400	
Grey & Black	6,500	
Ind. Printing Colours	23,100	
		2,08,400
VAT POWDER		
Yellow	10,800	
Orange	19,600	
Brown	20,000	
Red	11,200	
Violet	39,400	
Blue	1,50,500	
Hydron Blue	46,700	
Olive & Green	1,14,400	
Grey & Black	51,300	
		4,63,900
BRENTHOLS		
Brenthols	7,88,600	
Brenthol Bases	3,75,300	
Brenthol Salts	9,26,300	
Rapids & Rapidogens	75,600	
		21,65,800
SOLEDONS (Indigosols)	46,800	
		46,800
SPECIAL DYES	67,700	67,700
GALLO & PRINTING COLOURS	600	600
PALATINES	12,500	12,500
AUXILIARY PRODUCTS	19,15,600	19,15,600
ANILINE SALT	2,80,800	2,80,800
ANILINE OIL	1,500	1,500
Grand Total		1,45,75,600

APPENDIX III

LIST OF DYES FOR A 15-YEAR PLAN.

I. G.	I. C. I.
Direct Brown M	Chlorazol Brown MS
Congo Red	Congo Red I.C.I.
Diazo Black BH	Chlorazol Black BHS Chlorazol Black ES
Diamine Bordeaux	Chlorazol Bordeaux BS
Direct Green BG	Chlorazol Green BNS
Benzo Violet O	Chlorazol Violet O
Benzopurpurine 4B	Chlorazol Scarlet 4BS Benzopurpurine 4BS
Chrysophenine	Chrysophenine
Pluto Brown GG	Chlorazol Brown GG
Bismarck Brown	Bismarck Brown
Victoria Blue B	Victoria Blue BS
Methyl Violet 2B	Methyl Violet 2BS
Malachite Green	Malachite Green
Auramine O	Auramine OS
Methylene Blue	Methylene Blue 2BS
Brilliant Green	Brilliant Green X'ls. YS
Indanthrene Brilliant Green B	Caledon Jade Green B 2100 Pdr.
Indanthrene Brilliant Green GG	Caledon Jade Green 2G 2100 Pdr.
Indanthrene Brilliant Green 4G	Caledon Jade Green 4G 2100 Pdr.
Indanthrene Dark Blue BO	Caledon Dark Blue BM 800 Pdr.
Indanthrene Direct Black RB	Caledon Direct Black AC 500 Pdr.
Indanthrene Brill. Violet 2R	Caledon Brill. Purple 2R 800 Pdr.
Indanthrene Brill. Violet 4R	Caledon Brill. Purple 4R 800 Pdr.
Indanthrene Blue RSN	Caledon Blue R 800 Pdr.
Indanthrene Blue BC	Caledon Blue RC 800 Pdr.
Indanthrene Blue GCD	Caledon Blue GCD 800 Pdr.
Indanthrene Golden Orange 3G	Caledon Gold Orange 3G 800 Pdr.
Indanthrene Brown R	Caledon Brown R 800 Pdr.
Indanthrene Olive R	Caledon Olive R 800 Pdr.
Sulphur Black	Thionol Carbon BXK Conc. Grains
Indo Carbon CL	Thionol Carbon CL
Hydron Blue	Hydron Blue
Brilliant Croceine M	Croceine Scarlet 3 BDS
Metanil Yellow	Metanil Yellow YK
Orange II	Naphthalene Orange G
Indigosol O	Soledon Indigo LLS Pdr.
Indigosol 04B	Soledon Blue 4BCS Pdr.
Indigosol Green IB	Soledon Jade Green XS Paste
Naphtol AS	Brenthol AS
Naphtol AS—BS	Brenthol MN
Naphtol AS—BO	Brenthol AN
Naphtol AS—SW	Brenthol BN
Yellow GC Base	Brenthol Fast Yellow GC Base
Yellow GC Salt	Brenthol Fast Yellow GC Salt
Red B Base	Brenthol Fast Red B Base
Red B Salt	Brenthol Fast Red B Salt
Orange GC Base	Brenthol Fast Orange GC Base
Orange GC Salt	Brenthol Fast Orange GC Salt
Orange GR Base	Brenthol Fast Orange GR Base
Orange GR Salt	Brenthol Fast Orange GC Salt
Scarlet R Base	Brenthol Scarlet R Base
Scarlet R Salt	Brenthol Scarlet R Salt
Bordeaux GP Base	Brenthol Bordeaux GP Base
Bordeaux GP Salt	Brenthol Bordeaux GP Salt
Fast Garnet GBC Base	Brenthol Fast Garnet GBC Base
Fast Garnet GBC Salt	Brenthol Fast Garnet GBC Salt
Fast Scarlet GG Salt	Brenthol Fast Scarlet GG Salt
Alizarine	Alizarine

APPENDIX IV (a)

REQUIREMENTS OF BASIC, INORGANIC RAW MATERIALS REQUIRED FOR THE MANUFACTURE OF THE INORGANIC CHEMICALS LISTED IN APPENDIX IV (b).

		Tons.
1.	Ammonia	1,216
2.	Bauxite (55 per cent. Al_2O_3)	546
3.	Bromine	41
4.	Chlorine	2,132
5.	Chrome ore (50 per cent. Cr_2O_3)	1.260
6.	Copper	114
7.	Fluospar	13
8.	Iodine	lbs. 50
9.	Iron	501
10.	Lead	77
11.	Limestone (75 per cent. $CaCO_3$)	7,557
12.	Magnesium carbonate	167
13.	Mercury	1
14.	Phosphorus	14
15.	Potassium chloride	814
16.	Potassium nitrate	100
17.	Pyrolusite (80 per cent. MnO_2)	300
18.	Selenium	5
19.	Sodium chloride (including that used for chlorine)	26,975
20.	Sodium sulphate	2,032
21.	Sulphur	5,528
22.	Zinc	77.

APPENDIX IV (b)

LIST OF REQUIREMENTS OF INORGANIC CHEMICALS AND A STATEMENT OF THEIR AVAILABILITY.

Name	Total requirement (Tons) (1)	*Total production (Tons) (2)	Percentage of (2) in relation to (1) (3)
Acid chlorsulphonic	60	....	....
,, hydrochloric, ordinary tech. (sp. gr. 1.18).	1,700	2,500 of sp. gr. 1.18	147.1
,, conc. free for sulphuric acid	250		
,, fuming 39 per cent.	5	....	....
,, nitric, ord. tech.	4,500	2,750	61.1
,, fuming (sp. gr. 1.50-1.52)	7	....	....
,, sulphuric, conc. ord. tech. (1.84)	10,000	97,000	970
,, sulphuric monohydrated (100 per cent. sulphuric acid)	600	....	....
,, sulphuric fuming (oleum) 15-18%	80	350	437.5
25%	1,000	....	....
40%	300	....	....
60%	600	....	....
68%	20	....	....
Bases.			
Liquor ammonia (sp. gr. 0.58)	250	(See anhyd. NH_3)	....
Lime (fresh CaO) (60-65%)	500	Plenty	....
Chalk 75%	550	Plenty	....
Caustic potash	500	120	24
Soda ash	1,800	89,000	4,900
Caustic soda	4,000	16,500	412.5
Potassium carbonate	50	....	....
Sodium bicarbonate	10	....	....
Salts.			
Aluminium sulphate dry	30 of anhydrous (–58.4 of hydrated)	12,000 of hydrated	20,540
,, chloride	500	Nil.	....
Ammonium chloride	20	300	1,500
Copper sulphate	400	4,000	1,000
Cupric chloride	2	....	....
Cuprous ,,	1	....	....
Ferric ,,	2	....	....
Phosphorus chloride	50	....	....
,, oxychloride	5	....	....
Potassium nitrate	100	15,000	15,000
,, chloride	15	400	2,666
Sodium acetate	80	....	....
,, acetate (fused)	420	....	....
,, Bisulphite	20	Produced quantity not known.	
,, Bromide	1	Yes	
,, borofluoride	5	Nil	
,, chloride	10,000	Plenty	....
,, chlorate	10	Pot. compound is manufactured.	

*This includes maximum capacities of present plants and plans for expansion.

Name	Total requirement (Tons) (1)	*Total production (Tons) (2)	Percentage of (2) in relation to (1) (3)
Sodium dichromate	1,000	3,960	(Both sod. and pot.)
,, hydrosulphite	40	Nil	....
,, hypochlorite soln. (15%)	300	Salt available	....
,, nitrite	200	Nil	....
,, pyrosulphate	40	Nil	....
,, Sulphide cryst. ($9H_2O$)	2,500	Nil	....
,, sulphate ($10H_2O$)	200 (Also 2000 for manufacture of Na_2S)	2,000 (Also large quantities in Jodhpur)	90.9
,, Sulphate (anhyd.)	200	Nil	....
,, thiosulphate	20	Nil	....
Sulphuryl chloride	75	Nil	....
Sulphur dichloride	60	Nil	....
Zinc chloride	50	1,200	2,400
Metals.			
Iron filings	500	....	....
Zinc	50	....	....
Non-metals.			
Bromine	40	200	500
Chlorine gas (in cylinders)	800	2,000	250
Iodine	50 lbs.	Nil	....
Sulphur	750	....	....
Selenium	5	....	....
Oxides.			
Litharge (95% PbO_2)	10	....	....
Manganese dioxide (80% pyrolusite)	300	2,200	733
Mercuric oxides (Yellow)	1	Nil	....
Gases.			
Ammonia	5 (Also 1,047 for nitric acid manufacture)	925	88
Carbon dioxide	150	330	220
Phosgene	5	Nil	....
Sulphur dioxide	30	Nil	....
Hydrogen	25	Large quantities.	

APPENDIX V

LIST OF REQUIREMENTS OF COAL TAR RAW MATERIALS AND A STATEMENT OF THEIR AVAILABILITY.

Name	Total requirements in tons (1)	Total production in tons (2)	Percentage of (2) in relation to (1)
Benzene pure	400,000 gals.	2,417,000 gals. benzole 90's	604.5
Toluene ,,	125,000 gals.	374,000 gals.	299.2
Naphthalene pure	1,000 tons	1,100 tons	110
Anthracene ,,	500	120	24
Pyridine	2,000 gals.	225 gals.	11.25
Carbazole	15 tons	Nil	....
Solvent naphtha	4,000 gals.	288,500	7,212

APPENDIX VI

LIST OF REQUIREMENTS OF ALIPHATIC RAW MATERIALS AND STATEMENT OF THEIR AVAILABLITY.

Alcohol ord.	125 tons	28,500 tons	17,510
,, absolute	36 ,,		
Methyl alcohol	286	420	150
Acetic acid (40%)	50	....	....
,, ,, glacial	100		
Acetic anhydride	150	Nil	....
Formaldehyde 40%	20	85	425
Glycerine	125	1,850	1,460
Ethyl chloride	30	....	....
Turkey Red oil	5	Manufactured, but quantity not known.	

APPENDIX VII

Air Mail

(COPY)

IMPERIAL CHEMICAL INDUSTRIES LTD

Telegrams : 'BRIDYCOR'
Manchester

DYESTUFFS GROUP

HEXAGON HOUSE,
BLACKLEY,
MANCHESTER 9.

Reply to be addressed to Imperial Chemical
Industries Ltd.,
Dyestuffs Group

(Letters to P.O. Box 42)

Ref. IND-10

29*th April* 1942.

SIR ARDESHIR DALAL,
CHAIRMAN, DYESTUFFS EXPLORATORY COMMITTEE,
BOARD OF SCIENTIFIC AND INDUSTRIAL RESEARCH,
BOMBAY HOUSE, FORT, BOMBAY.

DEAR SIR ARDESHIR,

INDIAN DYESTUFFS FACTORY.

I am now in a position to let you have the information requested at the meeting of the Dyestuffs Exploratory Committee in Bombay on 26th April, 1941. The basis for the figures has been the list of dyestuffs which was prepared in collaboration with Dr. Venkataraman. The anticipated sales in India of these dyestuffs, in terms of I.C.I. standard colour, were passed to you by me under cover of a letter dated 30th April 1941. The total value of these dyestuffs, based on the pre-war c.i.f. prices, is £1,112,000 made up as follows :—

	£
Azo dyestuffs	170,000
Basic dyestuffs	36,000
Sulphide dyestuffs	70,000
Anthraquinone and Soledon dyestuffs	550,000
Azoic dyestuffs	192,000
Alizarine	94,000

The total weight of parent dyestuffs amounts to 4,650 tons and for this quantity there are required :

	Tons.
6 coal tar raw materials	2,650
129 coal tar intermediates	7,420
7 main aliphatic organic chemicals	630
30 main inorganic raw materials	24,000
Total	34,700

The coal tar raw materials are as follows :

Benzene	300,000	Gallons.
Toluene	125,000	,,
Solvent naphtha	4,000	,,
Naphthalene	700	Tons.
Carbazole	10	,,
Phenol	60	,,

In the calculations it has been assumed that intermediates required for the anthraquinone dyestuffs will be manufactured from naphthalene. This is because on the information at present available there is insufficient anthracene to meet the requirements starting from this raw material. If, however, crude anthracene containing 200 tons 100 per cent. anthracene is obtainable, 37 of the intermediates made from naphthalene may be manufactured from anthracene as starting material.

I am sorry to say that the sample of benzene which you arranged to be sent from Tatanagar did not arrive in Bombay before my baggage left by sea for England, but another sample of Indian crude benzole which has been examined here does not suggest that any difficulties will be encountered in purifying it to the requisite standard for use in dyestuffs manufacture.

I understood whilst in India that it is possible to purify Indian toluene to nitration quality and this is satisfactory for dyestuffs.

Similarly with regard to naphthalene, no undue difficulty is anticipated in obtaining a product to I.C.I. specification requirements.

In the case of anthracene, the samples examined were of much lower strength than is usual for starting point in dyestuffs manufacture and

(i) the ratio of carbazole to anthracene

(ii) the organic matter insoluble in xylene

are both much higher than in the material purchased by us and we would not be prepared to accept material of this quality as starting point for our processes. I am at present unable to say whether the material is capable of purification on an economic basis to meet our usual standard. This point regarding anthracene is, however, of minor importance because, as mentioned above, there appears to be insufficient anthracene available and it can be replaced by naphthalene

			Tons.
Benzene enters into	56	of the intermediates, totalling	4,500
Toluene ,,	34	,, ,, ...	885
Naphthalene ,,	6C	,, ,, ...	2,430
Phenol ,,		,, ,, ...	117

In numerous instances more than one of the coal tar raw materials is used in the manufacture of an intermediate or dyestuff and hence in the above table the number and total weight of the intermediates appear to be more than the 129 and 7,420 tons respectively given above.

The more important intermediates are :—

	lbs.		lbs.
Nitrobenzene	1,400,000	∝ -Naphthylamine	470,000
Aniline	340,000	β-Naphthylamine	100,000
Aniline salt	45,000	Sodium naphthionate ..	600,000
Nitroanilines	140,000	H-Acid	80,000
Aniline sulphonic acids ..	110,000	Gamma Acid	30,000
Alkylanilines	200,000	J-Acid	30,000
Benzidine	250,000	Phthalic anhydride	370,000
Dinitrobenzene	55,000	Benzanthrone	125,000
Chlorobenzene	1,600,000	2:3-Hydroxynaphthoic acid ..	370,000
Chloronitrobenzenes	610,000	Anthraquinone sulphonic acids	260,000
Chlorodinitrobenzene ..	2,250,000	Benzaldehyde	35,000
Anisidines	200,000	Benzoic acid	10,000
Nitroanisidines .. .	375,000	Benzoyl chloride	30,000
β-Naphthol	610,000		

The number of chemical operations involved in the manufacture of each of the 129 intermediates varies from one to nine and, to take an example, in the manufacture of H-acid there are the following stages :

Monosulphonation
Trisulphonation
Nitration
Lime out
Sodiation
Reduction
Fusion
Acidification
Purification

each of these operations being carried out in a separate item of plant.

The chemical operations called for include :

Nitration
Iron reduction
Electrolytic reduction
Catalytic reduction
Sulphide reduction
Sulphonation
Acetylation
Benzoylation
Chlorination
Bromination
Alkoxylation
Alkylation
Amination
Phenylation
Caustic fusion
Carboxylation
Nitrosation
Condensation
Hydrolysis
Benzidine transformation
Coupling
Phosgenation
Oxidation
Catalytic oxidation
Liming out
Sodiation

In addition to these chemical operations, there are, of course, the usual physical operations of distillation and fractionation, steam distillation, sweating, evaporation, drying, etc.

It is also perhaps as well to point out that although the chemical operation of nitration or sulphonation occurs in the manufacture of many of the 129 intermediates, it frequently happens that special plant is necessary in each case on account of the particular chemicals involved. Again to give an example, the plant for the manufacture of sulphanilic acid differs entirely from that needed for metanilic acid although these are both aniline sulphonic acids.

Aliphatic organic chemicals are required as follows :

	lbs.
Acetic acid glacial	150,000
Acetic anhydride	166,000
Ethyl chloride	61,000
Glycerine	184,000
Methanol	656,000
Methylated spirits	180,000
Turkey Red oil	10,000
	1,407,000

The main inorganic raw materials required are :

	Tons.
Aluminium chloride	316
Ammonia anhydrous (for nitric acid)	435
Ammonia liquor as 100%	80
Ammonium sulphite	4
Bromine	32
Caustic potash solid	400
Caustic soda as 100%	1.430
Chlorine	740
Carbon dioxide	143
Hydrochloric acid 100%	490
Hydrogen (for catalytic reductions)	21
Iron borings	228
Lead dioxide	77
Mixed acid for dinitrations	1,620
Mixed acid for mononitrations	2,800
Nitric acid 100%	1,520
Oleum 20% as 100% sulphuric acid and sulphuric acid as 100%	8.600
Phosgene	4
Phosphorus oxychloride	3
Phosphorus trichloride	51
Potassium carbonate	13
Salt cake (for dyestuffs and sodium sulphide)	1.880
Selenium	5
Soda ash	870
Sodium bicarbonate	6
Sodium bisulphite 40% actual weight	226
Sodium borofluoride	4
Sodium hypochlorite 15% chlorine	304
Sodium hydrosulphite	18
Sodium nitrite	196
Sodium pyrosulphate	37
Sodium sulphide 62½%	770
Sodium sulphide crystals	820
Sodium thiosulphate crystals	15
Sulphur dioxide liquid	16
Sulphuryl chloride	56
Zinc chloride	26
Total	24,186

The foregoing lists, while not exhaustive, contain all the more important items and those which are omitted are likely to be available in India in the quantities required.

The estimated capital cost of the plants for the manufacture and purification of the above-mentioned coal tar raw materials, intermediates and inorganic raw materials amounts to £4,000,000. This sum makes no provision for the purchase and development of the site or for power plant, boiler plant, maintenance workshops, warehouses, offices, buildings working capital, etc., necessary to provide the services for the operation of the factory. A complete factory including all these items would cost £7,000,000—£8,000,000 under the conditions in England in 1941.

In considering the coal tar raw materials it has been assumed that crude benzol mixture and whizzed naphthalene will be available in the quantities required and money has been included for the purification of these to the requisite quality. No provision has been made for the purification of tar acids to pure phenol.

Of the inorganic raw materials, provision has been included for :

1. Manufacture of hydrogen and nitrogen for synthetic ammonia and for hydrogen reductions. The greater proportion of the synthetic ammonia is utilised for the manufacture of nitric acid.
2. Manufacture of nitric acid by the catalytic oxidation of ammonia and its concentration to 94% HNO_3. Recovery of sodium nitrite from the exit gases.
3. Manufacture of 20% oleum and 100% H_2SO_4 and recovery of sodium bisulphite from the exit gases.
4. Manufacture of 65% oleum.
5. Manufacture of the total chlorine requirements of the factory and recovery of the equivalent amount of caustic soda liquor 100% Tw. It is assumed that the deficiency of caustic soda will be purchased. Sodium hypochlorite 15% will be recovered from the exit gases.
6. Manufacture of sodium sulphide from salt cake.
7. Recovery of spent sulphuric acid in a state suitable for re-use.

No provision has been made for the manufacture of aluminium chloride, carbon dioxide, sulphuryl chloride, salt cake, sulphur dioxide liquid, sodium hydrosulphite or zinc chloride.

Of the aliphatic organic chemicals, provision has been included only for the manufacture of

1. Ethyl chloride
2. Turkey Red oil.

At one or two of the meetings of the Dyestuffs Exploratory Committee, I referred to the extreme toxicity of certain of the dyestuffs intermediates, particularly α-naphthylamine and 5-chloro-*o*-toluidine and Dr. Venkataraman requested reference to published information on the matter. I have gone into this with Dr. Goldblatt, Medical Officer of I.C.I. (Dyestuffs) Ltd., and he recommends the following books :

1. "Occupation and Health," four volumes, produced by the League of Nations.
2. "Industrial Maladies," by Sir Thomas Legge.
3. "Occupational Skin Diseases," by Schwartz and Tulipan.
4. "Lehrbuch der Gewerbehygiene," by Franz Koelsch.

At the meeting of the Dyestuffs Exploratory Committee on 30th June, 1941, when Dr. Venkataraman undertook to analyse the coal tar raw materials produced in India from indigenous coal, I pointed out that when it was proposed to use the raw materials as the starting point for intermediates for manufacture of dyestuffs it was desirable for the analyses to be carried out by standard methods, so that the results of the analyses could be interpreted in England. I am now able to send you copies of I.C.I. Dyestuffs' standard official methods of analysis for benzene, toluene, naphthalene, anthracene and anthraquinone, and these will follow by sea mail.

Yours sincerely,

(Sd.) H. S. PINK.

APPENDIX VIII

LIST OF INORGANIC CHEMICALS FOR THE DYESTUFF INDUSTRY.

A—Acids.

Acid chlorsulphonic ($ClSO_3H$) Acid hydrochloric (sp. gr. 1.18), ordinary technical quality.
Acid hydrochloric conc. free from sulphuric acid.
Acid ,, fuming, 39%.
Acid nitric conc., ordinary technical quality.
Acid ,, fuming (sp. gr. 1.50).
Acid sulphuric conc. (sp. gr. 1.84), ordinary technical quality.
Acid ,, monohydrate (100% H_2SO_4).
Acid ,, fuming (oleum) 70% SO_3.

B—Alkalies.

Liquor ammonia (sp. gr. 0.88).
,, ,, (free from pyridine bases).
Lime (fresh CaO)
Caustic potash.
Soda ash.
Caustic soda.

C—Salts and Compounds.

Aluminium chloride (anhydrous)—$AlCl_3$.
,, ,, (anhydrous, resublimed).
,, nitrate—$Al(NO_3)_3, 9H_2O$.
,, sulphate (anhydrous)—$Al_2(SO_4)_3$.
Ammonium chloride—NH_4Cl.
,, sulphide
,, ,, yellow (polysulphide)—$(NH_4)_2S_4$.
,, sulphite—$(NH_4)_2SO_3, 6H_2O$.
Antimony pentachloride—$SbCl_5$.
Barium chloride—$BaCl_2, 2H_2O$.
Calcium chloride—$CaCl_2, H_2O$.
Copper sulphate—$CuSO_4, 5H_2O$.
Cupric chloride—$CuCl_2, 2H_2O$.
Cuprous ,, —Cu_2Cl_2.
Copper nitrate—$Cu(NO_3)_2, 3H_2O$.
Ferric sulphate—$Fe_2(SO_4)_3, 9H_2O$.
,, nitrate—$Fe(NO_3)_3, 9H_2O$.
Magnesium bromide—$MgBr_2, 6H_2O$.
Phosphorous trichloride—PCl_3.
,, pentachloride—PCl_5.
,, oxychloride—$POCl_3$.
Potassium acetate—CH_3COOK
,, chlorate—$KClO_3$.
,, cyanide—KCN.
,, formate—HCOOK.
,, fluoride—KF, $2H_2O$.
,, nitrate—KNO_3.
,, permanganate—$KMnO_4$.

Silver fluoride—AgF.
Sodium acetate —$CH_3COONa, 3H_2O$.
,, ,, —(anhydrous, fused)—CH_3COONa
,, bisulphite—$NaHSO_3$.
,, bromide—$NaBr, 2H_2O$.
,, chloride—(common salt)—$NaCl$.
,, chlorate—$NaClO_3$.
,, cyanide—$NaCN$.
,, dichromate—$Na_2Cr_2O_7, 2H_2O$.
,, hydrosulphite—$Na_2S_2O_4, 2H_2O$.
,, nitrate—$NaNO_3$.
,, nitrate—$NaNO_2$.
,, sulphide (crystals)—$Na_2S, 9H_2O$.
,, sulphate (Glauber's salt)—$Na_2SO_4, 10H_2O$.
,, thiosulphate—$Na_2S_2O_3, 5H_2O$.
Stannous chloride—$SnCl_2, 2H_2O$.
Sulphur chloride—S_2Cl_2.
Sulfuryl chloride—SO_2Cl_2.
Thionyl chloride—$SOCl_2$.
Zinc chloride—$ZnCl_2, 2H_2O$.
,, ,, (anhydrous)—$ZnCl_2$.

D—Metals.

(As powder or filings, except in the case of mercury and sodium.)

Aluminium
Copper
Cast Iron
Mercury
Nickel
Sodium
Tin
Zinc

E—Non-metals.

Bromine
Chlorine (in cylinder)
Iodine
Phosphorus
Sulphur

F—Oxides.

Lead peroxide—PbO_2
Manganese dioxide—MnO_2
Molybdenum trioxide—MoO_3
Vanadium pentoxide—V_2O_5

G—Gases.

(In cylinders under pressure)

Ammonia—NH_3
Carbon dioxide—CO_2
Phosgene—$COCl_2$

APPENDIX IX

20th September, 1941.

Dear Sirs,

With reference to an enquiry we are conducting on behalf of the Board of Scientific and Industrial Research on the raw materials available in India for a dyestuff industry, I shall be very grateful if you would be good enough to let me have detailed information regarding the chemicals in the enclosed list which you are producing. Data for each chemical may kindly be provided under the following heads :—

1. Present output (for the years 1938-39, 1939-40 and 1940-41)
2. Present capacity
3. Extent to which capacity could be expanded
4. Present sale price
5. Sale price during the years 1938-39, 1939-40 and 1940-41
6. Detailed specifications regarding the quality of each chemical

An additional list of chemicals, which you are not producing at present, but which you are planning to produce in the near future, together with the projected output and probable sale price, would be extremely valuable.

The data supplied by you will be regarded as strictly confidential, and will only be used for the purposes of a report to be submitted to the Director of Scientific and Industrial Research.

Yours faithfully,
K. VENKATARAMAN,
Head of Department.

APPENDIX X

List of firms and persons to whom Appendices VIII and IX were sent.

Directors of Industries of the following provinces :—

1. Assam* ; 2. Bombay* ; 3. Bengal* ; 4. Bihar* ; 5. Central Provinces and Berar* ; 6. Madras* ; 7. North West Frontier Province* ; 8. Orissa* ; 9. Punjab* ; 10. Sind* ; 11. United Provinces* ; 12. Baroda* ; 13. Kashmir (Jammu)* ; 14. Hyderabad (Deccan)* ; 15. Mysore.*

16. The Indian Chemical Manufacturers' Association.*

16A. The Director General of Intelligence, and Statistics, Calcutta*.

Industrial concerns :—

17. The Alkali and Chemical Corporation of India, Calcutta.*
18. De Walde & Co., Ltd., Calcutta.*
19. The Mettur Chemicals, Ltd., Mettur, S. India.*
20. Shambhunath and Sons, Ltd., Amritsar.*
21. Alembic Chemical Works, Ltd., Baroda.*
22. Bengal Chemical and Pharmaceutical Co., Ltd., Calcutta.
23. The Dharmsi Morarji Chemical Co., Ltd., Bombay.
24. Messrs. Parry & Co., Ltd., Madras.*
25. The Eastern Chemical Co., Ltd., Bombay.*
26. The Tata Chemicals Ltd., Mithapur.*
27. The Dhrangadhra Alkali Works (Agents : H. M. Mehta and Co., Bombay).*
28. Pioneer Magnesia Works, Bombay.*
29. The Indian Chemical and Pharmaceutical Industries, Calcutta.
30. The Calcutta Chemical Co., Calcutta.
31. The Dr. Bose's Laboratories, Calcutta.
32. The Madras Chemical Industries, Madras.*
33. The Madras Alkali and Chemical Works, Madras.
34. The Killick Nixon & Co., Bombay.*
35. The Pioneer Chromate Works, Bombay.
36. Indentors' Syndicate, Bombay.*
37. Windsor Industrial Corporation, Bombay.*
38. The Chemical Engineers, Bombay.
39. The Indian Copper Corporation, Ghatsila.*
40. The Arya Mining and Trading Corporation, P.O. Barajumda.
41. Dehri Rohtas Lime Co., Dehri-on-Sone.
42. Rohtas Industries, Dalmianagar.*
43. Barkar Coal Co., Sijina.
44. Bararee Coke Co., Kusunda.*
45. Gulab Seth & Co., Badan Bazar.
46. Jharia Sulphuric Acid, Ltd., Jharia.*
47. Mysore Chemicals and Fertilisers, Ltd., Mysore.*
48. The Mysore Chemical Mfg. Co., Bangalore.
49. The Tata Iron and Steel Co., Jamshedpur.*
50. The Ramco Chemical Works, Ahmedabad.
51. The Cawnpore Chemical Works, Cawnpore.*
52. The H. Mumtaz & Co., Calcutta.
53. The Bihar Chemical Industries, Monghyr.
54. The Mining and Chemical Industries, Ltd., New Delhi.
55. The Eastern Pharmaceutical Co., Lahore.
56. The Frontier Chemical Works, Rawalpindi.
57. Indian Chemical Manufacturers, Ltd., Lahore.*
58. The Petlad Turkey Red Dye Works, Petlad.
59. The Cape Copper Co., Singhbhum.

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* The parties concerned have replied to the questionnaire.

APPENDIX XI

PRODUCTION FIGURES FOR INORGANIC CHEMICALS (INCLUDING PLANS FOR EXPANSION).

Chemical	Present output in tons			Present capacity in tons	Extension in tons	Present sale price Rs./ton	Sale price in Rs. per ton during			Specifications
	1938-39	1939-40	1940-41				1938-39	1939-40	1940-41	
1	2	3	4	5	6	7	8	9	10	11
Acid hydrochloric	607	621	629	896	+60	0 3 5 lb. (from 0 1 10 to 0 5 0 lb.)	255	302 8	302 8	(Sp. gr. 1.1—1.17) About 30-35%. About 12,000 lbs. is W/W B.P. quality.
Acid hydrochloric concentrated, free from sulphuric acid ..	..	..	..	2.7	..	1 2 a lb.	..	..	..	B.P. quality, free from sulphuric acid.
Acid nitric	370	512	331	414	+228	600 0 0 a ton 0 4 4 a lb. (0 5 0 to 0 3 8 a lb.)	390	650	625 0	70-75%
Do.	55	53	34	96	+48	..	..	..	..	55%
Acid nitric fuming	..	..	..	Produced by one firm, but no details given.						
Acid sulpuhric	12,741	15,296	18,613	28,376	+8	188 0 0	117 0	177 0	194 0	1.84 Sp. gr., 95-98%
Do. Concentrated ..	189	237	290	720	+360	..	..	..	..	70-75%
Do. Fuming (oleum) ..	..	..	..	350	..	450 to 500	..	..	..	20% free SO_3
Lime	27,776	29,907	33,144	28,765	Any quantity	..	..	..	..	Chemical lime, 90% lime, flux lime, etc.
Liquor ammonia	..	..	..	8.1	..	0 12 0 a lb. naked.	..	..	..	Sp. gr. 0.910; 25% W/W B.P. quality.
Caustic potash	..	..	..	..	120 planned for future.	3,000	..	..	..	..
Soda ash	..	..	..	16,000	+72,900	130 0	135 0	135 0	135 0	
Caustic soda	..	..	1,350	3,923	+12,400 planned	400 (solid 133-200 for 48% lye.)	..	..	128 0 48% lye.	Part as solid and part as 48% lye.
Barium chloride	..	..	..	2	..	1 0 0 a lb.	..	..	..	Pure laboratory quality.
Bleaching powder	..	..	..	2,625	+4,000 planned.	700 0	..	..	..	35-37% Available chlorine.
Calcium chloride	..	..	..	6,000	Any quantity.	..	..	..	..	..
Copper sulphate	..	..	..	125	+60	600 0	..	..	..	98.5% $CuSO_4$ $5H_2O$ 1% $FeSO_4$ $7H_2O$
Potassium acetate	..	..	..	2.7	..	1 14 a lb.	..	..	..	B.P. quality.
Potassium nitrate	..	..	15.2	+228	..	0 8 lb.	..	..	..	B.P. quality.
Potassium permanganate ..	..	..	..	..	120 planned.	4 8 lb.	..	..	..	..
Salt	20,271	20,051	27,304	31,256	+1,51,500	25 0 per ton	25 Ex duty	25 Ex duty	25 Ex duty	
Sodium dichromate	..	..	..	144	+36	2,000	..	..	..	
Sodium sulphate $10H_2O$ ..	26	50	61	259*	..	118	100 0	100 0	100 0	*Out of this 175 tons can be manufactured only as an alternative to 90 tons of anhydrous sodium sulphate.
Sodium sulphate anhydrous ..	..	45	51	90	..	200	200 0	200 0	200 0	
Zinc chloride	..	..	..	..	1,200 planned.	..	..	..	..	
Bromine	..	..	..	..	200 planned.	..	..	..	..	....
Chlorine gas	..	..	1,350	1,950	+115 planned	395 a ton drums.	..	375 a ton drum	375 a ton drum	99-99.9% chlorine.
Manganese dioxide	8,255	5,423	2,462	2,120	+44	45 0 F.O.R. Mines.	39 0	..	..	86% MnO_2 pyrolusite.
Ammonia gas	..	..	..	1,750	..	1 0 0 lb.	..	..	..	
Carbon dioxide	131	95	132	330	..	0 3 9 per lb.	0 3 6	0 3 6	0 3 9	

APPENDIX XII

PRODUCTION FIGURES (IN TONS) FOR SOME HEAVY CHEMICALS, QUOTED FROM GOVERNMENT PUBLICATIONS (COLUMNS I, II AND III) AND A REPORT OF A COMMITTEE OF THE INDIAN CHEMICAL MANUFACTURERS' ASSOCIATION (COLUMN IV).

Description	Government Publications		Sen Gupta (1937)	Estimated present production
	1938–39 (12 months)	1939–40 (10 months only)		
	(I)	(II)	(III)	(IV)
Hydrochlorid acid—				
(a) ordinary or non-fuming.. ..	361	457	1,200	1,000
(b) fuming	..	..	..	..
Nitric acid—				
(a) ordinary or non-fuming.. ..	588	903	1.500	1,000
(b) fuming	..	..	..	..
Sulphuric acid—				
(a) ordinary or non-fuming ..	20,585	30,731	28,000 (for 1935-36)	50,000
(b) fuming	0.2	1	..	..
Aluminium sulphate	4,509	7,219	6,500 (including alum, alumino-ferric and alum cake).	5,000
Sodium sulphate (Glauber's salt) ..	832	1,322	1,200	1,000

APPENDIX XIII

QUESTIONNAIRE REGARDING COAL TAR RAW MATERIALS.

Bombay House, Fort, Bombay,
28*th March* 1941.

From

The Chairman,
Dyestuffs Exploratory Committee,
Board of Scientific and Industrial Research, Bombay.

Dear Sirs,

With reference to the work of the Exploratory Committee to consider ways and means for the manufacture of synthetic dyestuffs appointed by the Government of India, I shall be grateful if you would be good enough to let me have, at your earliest convenience, quantities and prices of the following coal tar products, which you are (a) manufacturing at present, and (b) likely to be able to produce in the event of a demand being created. If the particular quantities mentioned are not produced, but fractions with other specifications are being isolated, these may be included :—

1. Benzol, " nitration pure," sp. gr. 0.882—0.886 ; boiling range 1°C., starting not below 79.2°C.
2. Benzol, 90's ; sp. gr. 0.875—0.886 ; boiling range 90 per cent. below 100°C.
3. Toluol, " nitration pure," sp. gr. 0.869—0.873 ; boiling range 1°C., starting not below 109.4°C.
4. Xylol, " nitration pure," sp. gr. 0.865—0.870 ; boiling range 3°C., starting not below 137°C. ; dry not above 140.5°C.
5. Solvent naphtha, boiling range 130-155°C.
6. Pseudocumene, boils 95 per cent. from 165.5 to 175.5°C.
7. Naphthalene : Crude, 74°C. min. melting point.
   Purified, 78°C. ,, ,, ,,
   Refined, 79.6°C. ,, ,, ,,
8. Anthracene pure
9. Anthracene crude
10. Pyridine refined, b. p. 114-117°C ; colourless, with a pyridine content of about 96 per cent.
11. Pyridine (commercial)
12. Phenol, pure crystalline, m.p. 40°C.
13. Phenol (technical)
14. *o*-Cresol
15. *p*-Cresol
16. Xylenols
17. Crude tar acids

The object of the enquiry being essentially to obtain data regarding the availability of raw materials for the organisation of a dyestuff industry, any other information, which you consider, would be helpful to us, may kindly be provided.

Yours faithfully,

Chairman,
Dyestuffs Exploratory Committee.

APPENDIX XIV

LIST OF FIRMS, TO WHOM APPENDIX V WAS SENT.

1. Messrs. Burrakur Coal Co., Ltd., Calcutta.
2. Messrs. Lodna Colliery Co. (1920) Ltd., Calcutta.
3. Messrs. Tata Iron and Steel Co., Ltd., Bombay.
4. Messrs. Indian Iron and Steel Co., Calcutta.
5. Messrs. Shalimar Tar Products (1935) Ltd., Calcutta.
6. Messrs. Bararee Coke Co., Ltd., Calcutta.
7. Messrs. Bengal Chemical and Pharmaceutical Works, Ltd., Calcutta.

APPENDIX XV

PRODUCTION FIGURES FOR COAL TAR RAW MATERIALS (INCLUDING PLANS FOR EXPANSION).

Product	Yearly production	Price in Rs.	Remarks
Crude tar	19,200 tons	....	
Motor spirit–Benzol 90's .	24,17,000 gals.*	2 0 per gal.	
Benzol (pure nitratable)**	Manufactured but quantity not mentioned.	2 8 to 3 0 per gal.	
Toluol 90's	18,000 gals.	1 12 to 2 0 per gal.	
Toluol (pure nitratable) .	3,74,000 gals. †	2 8 per gal.	
Xylol (pure nitratable) . .	3,600 gals.	3 0 per gal.	
Pseudocumene	Nil	....	Present in heavy solvent naphtha (150-210°C.) total output is 9,000 gals.
Solvent naphtha ..	2,88,500 gals.	1 4 to 2 0 per gal.	Can be manufactured in any quantity, if required.
Naphthalene	1,088 tons	24 0 per cwt.	968 tons pure (79-80° m.p.); can be increased.
Anthracene	120 tons	....	Not produced at present but estimated production in immediate future.
Phenol (Tech. and pure) .	19 tons ‡	1 0 per lb.	Pure is not produced.
o-and *p*-Cresols ..	Nil	....	
Crude coal tar acids ..	26,000 gals.	2 8 to 3 0 per gal.	Up to 62,000 gals. possible.
Pyridine (Comm.) ..	225 gals.	....	Generally not profitable to manufacture due to small quantities present.

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*The figure shown against motor spirit is as an alternative for toluene, but as a raw material for synthetic dyestuff industry, motor spirit would give toluene as well as benzene. 772,000 gallons are produced at present, 445,000 gallons would be produced in the near future, and the remaining can be produced with additional equipment.

**Pure benzol could be produced from 90's benzol (100,000 gallons), to the extent of 55 per cent. by one firm, whereas another firm has reported that pure benzol could be extracted from 900,000 gallons of motor spirit available from them.

†May vary up to 395,000 gallons. The present total production is 170,000 gallons while extensions by one firm would give 45,000 gallons, the rest of the quantities would be obtained if two other concerns start manufacturing.

‡About 1,600 lbs. are in the form of crude carbolic acid which are manufactured at present. The remaining quantity can be manufactured in case there is a demand.

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APPENDIX XVII

A NOTE ON BY-PRODUCT FROM COAL.

WITH SPECIAL REFERENCE TO RECOVERY OF PRODUCTS OF SPECIAL CHEMICAL VALUE.

By Dr. C. FORRESTER, F.I.C., F.R.S.E., F.Inst. Fuel, etc.

FOREWORD

A draft note on similar lines was prepared in October 1942 for the information of the Basic Chemicals Committee. That note which was subject to much correction, was based on information regarding standard practice in countries other than India and also on incomplete information furnished by a section only of the Indian coking and coal tar industries. Certain firms declined to give information that would have given a more complete and reliable picture of the position in India. In consequence the first note contained certain assumptions that had to be modified in the light of later information.

The first note purported to be a provisional report of the Sub-Committee on coal tar products. The present note, while replacing it, cannot be so regarded and for various reasons it has been compiled as comprising the personal opinions of the present writer.

INTRODUCTORY AND GENERAL PRINCIPLES

The products of distillation (or coking) of coal—and of wood (to which the term "coking" is not applied)—differ from almost all the other materials with which the Basic Chemicals Committee was concerned in that whereas the latter, or the raw materials from which they are produced, are nearly all either single and simple chemical substances. or separable mixtures of such substances (e.g., crude sulphur, the Baluchistan sulphur. pyrites, carbide, the alcohols, the mineral acids, caustic soda, soda ash, salt cake, copper sulphate, bichromates, etc., etc.), the former are extremely complex mixtures of a very large number of chemical compounds. Well over 100 different chemical compounds have been isolated from coal tar. Most of these chemical compounds are themselves of complex molecular composition and structure and some of them are even of a chemical nature that has not yet been elucidated.

The separation of even a small proportion of the individual constituents of coal tar from each other is not a simple process. The chemical nature of the tar itself differs according to the conditions under which it is produced, even from one and the same coal. That is to say, the chemical compounds present in the tar produced by coking a sample of coal at a certain temperature, and their proportions, are not the same as those produced when the same coal is coked at a different temperature. Not only so but even if the same temperature is used, if one lot of the coal is coked quickly (raised up to the maximum temperature quickly) and another lot is coked slowly, the tar produced in the one operation will be found to differ materially from the tar produced in the other operation—*from one and the same coal.*

When, to that fact, we add the additional fact that two different coals give different compounds or at least different proportions of the same compounds when treated under exactly the same conditions, it will be realised that consideration of the problems met with in the coking of coal and of the subsequent treatment of the products (tar, etc.), is a matter that can be *competently* handled only by a technician possessing a considerable knowledge of its scientific aspects.

THE SUBSTANCES AND MATERIALS IN QUESTION

The relevant materials to which the attention of the Basic Chemicals Committee was first directed were :—ammonia, ammonium sulphate, benzene, naphthalene, toluene, creosote, di-ethylphthalate, dimethylaniline and dyestuffs. These substances have figured in precise "essential civil" and War Department demands. Two comments are called for :

(*a*) There are other coal by-products the demand for which exists but is concealed in the form of some other materials of which there is at present a deficiency. We must consider the extent to which some if not all of the latter demands may be met by manufacture in India.

(*b*) Dyestuffs can hardly, for the purposes of this enquiry, be considered within our purview. The prospects of establishing even the modest beginnings of a dyestuffs industry in India within a period of years is probably remote. Nevertheless it is probable that a few dyes that are comparatively simple to produce may be made within a reasonably short period.

The essential point to consider in respect of the dyestuffs industry is the nature of the materials whose production from coal and from its by-products concerns this Committee. These are the so-called "intermediates," in reality the raw materials of the industry. These intermediates are required as the starting points of industrial processes other than those of the dyestuff industry.

The initiation of some of these processes in India would undoubtedly assist in solving some of our supply problems, especially in respect of real demands for manufactured articles that conceal potential demands for these by-products of coal. These other industrial requirements are related to, among others, the dyestuffs, drugs and plastics industries. The following is a selection only of these so-called "intermediates":—

Primary from coal gas and coal tar:—Benzene, toluene, xylene, phenol (carbolic acid), cresol, the naphthols, the xylols, naphthalene, anthracene, pyridine, carbazol.

Secondary, or subsidiary, produced by further treatment of primary by-products.—Nitrobenzene, aniline, phthalic anhydride, betanaphthol, di-methylaniline, anthraquinone, benzidin, sulphanilic acid, naphthionic acid, chlorobenzene, nitrotoluene, toluidine, tolidine, salicylic acid, resorcinol.

It should be made clear that coal tar and other coal by-products are not the only sources of intermediates for the manufacture of dyestuffs, synthetic drugs or plastics.

Of the above primary by-products from the treatment of coal the bulk of the benzene and toluene come from the gas and not, as many erroneously think, from coal tar. Furthermore, coal distillation is not the only, or even the most important, source of ammonia, and its extraction from coal gas is practised only if it is an economic proposition or specially desirable, as in war-time. That aspect of the matter is illustrated by the fact that the imports of ammonium sulphate into India rose from 59,000 tons in 1936-37 to 91,400 tons in 1938-39 and certain by-product coking plants (those of Lodna and Bhowra) found it unprofitable to continue extracting the ammonia and fixing it in the form of ammonium sulphate. (This loss of ammonium sulphate has been calculated at about 1,200 tons of the salt per annum, based on the present reduced output of those two plants.)

From the foregoing, it will be seen that even in peace-time it is in the interests of the country that an intelligent coking and by-product extraction policy be adopted as essential to the efficient operation of the subsequent steps in the distillation of the tars.

FACTORS AFFECTING COKING OF COAL AND NATURE OF BY-PRODUCT

The proportions of all the primary distillation fractions and of the re-distillation fractions or compounds depend upon the following, among other, factors:—

(*a*) the geological type of the coal, (*b*) the design of the oven or retort, (*c*) the temperature to which the coal is heated, (*d*) the rate of heating up to that temperature, (*e*) the period for which heating is continued.

There are other less important factors.

As the different coke plants and gas companies obtain their supplies of coal from different sources and also operate different types of plant and operate them at different temperatures, it is necessary to consider any outstanding differences, in so far as they affect the primary object of the present enquiry. The bulk of India's coke is produced at coke plants making metallurgical coke for the iron and steel industry. It is manufactured from a comparatively small range of coals (geologically speaking) known as "coking coals" and the temperature employed in the ovens is the highest possible within reasonable limits. Consequently, there is no very great variation in the nature and proportions of the products. There are certain coke plants, however, in India whose coal is of such special quality, or whose plants are of such design or so operated, that their distillation products differ materially from those obtained from the other metallurgical coke plants in that they tend generally to contain appreciable proportions of certain chemically valuable constitutents. The former are those at Bhowra, Bararee Coke Company and Giridih. The latter are those of the Tata Iron and Steel Company, of the Indian Iron and Steel Company, of Turner Morrison and Company at Lodna and of Bird and Company's plant at Loyabad. The types of coal used for making "town gas" (at Calcutta and Bombay) and the design of plant are such as to render the by-products obtained at those plants different from these obtained from *any* of the metallurgical coke plants. The liquid by-products obtained from the gas plants and those from Bhowra, Bararee Coke Company and Giridih are all of greater chemical value (in the order of " merit " stated) than are those of the remainder of the coke plants. Consequently the Basic Chemical Committee is primarily concerned with the former.

The validity of this claim (regarding the tars from those plants, especially so far as the Giridih plant tar is concerned), is disputed by the Honorary Adviser on Tar Products, who has stated that the Giridih is the poorest but one of all Indian coal tars in this respect. The following figures relating to the composition of the tars from various plants do not support the Adviser's contention. The figures should be interpreted by reference to the respective quantities of naphthalene-free light and middle oil distillates and also quantities of " tar acids " :—

Analytical Figures Relating to Certain Constituents of Some Indian Coal Tars.

A Source of tar.	B Distillate between 170° + 270°C.	C Naphthalene	D Middle oil and creosote oil less naphthalene (B-C).	E Tar acids.
Oriental Gas Co.	21.5	6.4	15.1	2.6-5.0
Bhowra Coke Plant	19.7	1.7	18.0	4.60
Bararee Coke Co.	15.2	2.2	13.0	4.10
Giridih Coke Plant	18.2	6.3	11.9	2.2
Loyabad Coke Plant	14.3	7.4	6.9	Small
Tata's Plant :—				
(*a*) Electrostatic tar precipitation	25.6	16.3	9.3	Small
(*b*) Ordinary tar recovery ..	15.2	8.0	7.2	Small
Indian Iron and Steel Co. (*a*) ..	12.2	6.3	5.9	Small
(*b*)	8.0	6.5	1.5	Small

No information disclosed regarding Turner Morrison, Lodna Plant.

STATISTICS

Owing to the variations in the types of plants and to differences in operation of plants of the same or similar types the primary by-products of coal distillation cannot be grouped into a number of well-recognised standard products regarding which accurate statistics can be obtained. The same term is in some instances used for products of somewhat differing quality and even different nature. Not only so but one firm buys from another to blend the former's products with those of the latter and the resultant blend is put on the market in a form that renders its recognition as one or other of the multitudinous subsidiary by-products of the coking industry, a matter of some difficulty. The industry tends in certain instances to make a mystery of these technical matters and is somewhat reluctant to take into its confidence even the most reliable and responsible investigator. The combined result of these factors is that except for the most elementary products no reliable figures can be obtained from the industry regarding past production, essential requirements, possible increased output, etc.

Some of the individual pure—or nearly pure—products, particularly pheno (also known as carbolic acid), cresol and other chemically related compounds obtained in the course of redistillation of the primary products of the coking of coal are by themselves valuable antiseptics and disinfectants. Some of the primary redistillation tar products, especially creosote oil and middle oil, contain appreciable proportions of those chemical substances, and their disinfectant powers are to a considerable extent exploited by their being marketed without further redistillation for separation of phenol, etc., in the form of emulsions of the " phenyle" type. There is little doubt that many of these so-called disinfectant fluids are of little or no use for their purpose. Unfortunately there is at present no official control or inspection of such products, as there is of foodstuffs, and so it is not possible to estimate even approximately the proportion of valuable tar products that are thus wasted.

THE COKE AND GAS INDUSTRIES

There are five main divisions of the coal distillation industries :—

A. For the manufacture of hard metallurgical coke in by-product recovery ovens,

B. For the manufacture of hard coke (much of which is used for metallurgical purposes) in beehive ovens, in which no by-products are recovered,

C. For the manufacture of hard coke (much of which is, as in the case of beehive oven coke, used for metallurgical purposes), in open brick-sided ovens known as "country ovens," in which no by-products are recovered,

D. For the manufacture of the domestic (more or less) smokeless fuel known as "soft coke" (also used for industrial purposes), by the open-heap method in which no by-products are recovered,

E. For the manufacture of "town gas," also used for industrial purposes, the coke being sold as a by-product partly as an industrial fuel and partly for domestic purposes, various by-products being recovered, including tar.

For A, B and C (especially A), the best quality coking coals are required. The term "best quality" implies good coking proporties accompanied by comparatively low ash content. For D, coking coals possessing a comparatively high ash content are generally used, the soft coke industry being a legitimate outlet for the poorer grades of what would otherwise be excellent coking coal for metallurgical purposes. For E, a coal of medium or good coking quality possessing a high percentage of volatile matter and usually a comparatively high percentage of inherent moisture is required. The majority of the coals required for A, B, C and D are found in the Jharia Coalfield, though appreciable quantities of good coking coal are found in the Raniganj field as well as in among others, the Giridih field. The majority of coals required for E are found in the Raniganj field.

As no by-products are recovered in the operation of processes B, C and D, we are not concerned with them in this enquiry (except for a passing reference to soft coke below).

ORGANIZATION OF THE COAL DISTILLATION INDUSTRIES.

The bulk of the metallurgical coking industry is in the hands of two large concerns but other plants also produce metallurgical coke in by-product coke ovens. The manufacture of town gas is carried on only in Calcutta and Bombay and there is only one gas company in each of those towns. The following are the essential statistics :—

Company or Managing Agents.	Location of Plant.		Monthly Production of Coal Tar.
Metallurgical	*Coke Plants.*		
			Tons.
The Tata Iron and Steel Co.	Jamshedpur		3,700
The Indian Iron and Steel Co.	Hirapur	(R)	1,500
	Kulti	(R)	600
Bird & Co., The Barakar Coal Co.	Loyabad	(J)	200
Jardine, Skinner & Co.	..		—
Bararee Coke Company	Kusunda	(J)	200
Mackinnon Mackenzie & Co.	Bhowra	(J)	200
Turner Morrison & Co.	..		—
Lodna Collieries Co. (1920)	Lodna	(J)	150
State Railway Collieries	Giridih	(G)	75
Monthly Total ..			6,625

R = Raniganj Coalfield. J = Jharia Coalfield. G = Giridih Coalfield.

Total Annual Production :—

	Tons.
Tar from metallurgical coke plants	79,500 per annum.

Gas Plants.

	Monthly production. Tons.
The Oriental Gas Company, Ltd., Calcutta (stated to be 200 to 260).	260
The Bombay Gas Company, Ltd., Bombay	150 (approx.)
	410
Total Annual Production from gas companies	4,900
Grand Total of Annual Production of Coal Tar	84,400

In addition to these tar producing agencies in India there are other industrial undertakings concerned in the subsequent treatment of coal tar. These latter include :—

The Shalimar Tar Products	Calcutta and Lodna.
Bengal Chemical & Pharmaceutical Works Ltd.	Calcutta.

Behar Chemical Traders, Howrah, near Calcutta.

and the Bararee Coke Company above referred to also distil a considerable proportion of their tar.

The most important tar producing companies (i.e., the metallurgical coke and the gas companies) are members of a trade organization known as the Tar Producers' Association, whose declared object is to pool tar resources for the sake of distribution under a common policy to the various tar distillers. The companies represented in this Association are :—

The Tata Iron and Steel Company.

The Indian Iron and Steel Company.

Lodna Collieries Co. (1920) Ltd. (controlling the Lodna Coke Plant).

Bararee Coke Company, Bird & Co. (controlling the Barakar Coal Company's Loyabad Coke Plant).

It will be seen that there are two plants whose output is not at present controlled by the Association, namely, Mackinnon Mackenzie and Company's plant at Bhowra and the State Railway Plant at Giridih. It will also be seen that the most influential interests in the combine are those of the Tata Company and the Indian Iron and Steel Company, whose annual outputs as above computed represent 87.5% of the tar from the metallurgical coke producers and 82.5% of the total tar production including gas companies' tar.

It is an important claim of the Tar Producers' Association that by pooling resources and controlling distribution for either redistillation on further treatment prior to marketing they ensure the best and most efficient use of India's resources of tar.

The other trade association referred to in the preceding paragraph is the Coal Tar Distillers' Association, the constituent members of which are :—

Shalimar Tar Products (1935), Ltd.

Bengal Chemical & Pharmaceutical Works and Bararee Coke Company.

Of the above companies, the first (the Shalimar Company) is controlled by Turner Morrison & Co., and the last (Bararee Coke Company) is controlled by Jardine Skinner & Co. The former company is interested in the manufacture of creosote and road tar and also certain by-products useful in the manufacture of paints, Messrs. Turner Morrison being also managing agents for the Shalimar Paint, Colour and Varnish Company of Howrah (Calcutta) and also, of course, for the Lodna Coke Plant. The inter-relations of these subsidiary companies are such that any serious disturbances in the balance between the various by-products as at present obtained from coal tar is a matter for serious concern and it is natural that proposals for radical departure from existing established practice should be viewed with some apprehension or even disfavour.

THE IMPORTANCE OF ROAD TAR

The most important products of tar distillation in India, are at least those whose production goes far towards dictating distillation policy, are *road tar* and *creosote.* There are several road tars and their production necessitates conforming with certain standard specifications. These specifications, though confined for the most part to physical properties, necessitate the treatment of the crude coal tar in such a manner and by such processes that only a small proportion of certain valuable chemical constituents is obtained. The remainder inevitably remain in the road tar and are irretrievably lost. The total amount of certain of these substances normally present in coal tar as produced in metallurgical coke plants is in any case small—of the order of two or three per cent. These statements are not necessarily to be interpreted as adverse criticisms of present tar distillation or road treatment policy. They are merely statements of fact that merit special consideration during war-time.

So far as road tar specifications are concerned it appears that in general the British Standard Specifications have been adopted with slight (if any) modifications. There are three main specifications, applicable to Road Tars Nos. 1, 2 and 3. There is another specification for what is known in India as No. 3A and the Shalimar Tar Products Company market a thicker road tar known as " Hivis " (a name derived from the term "high viscosity").

In examining the problem of releasing a greater proportion of valuable chemical substances from coal tar, if necessary by adopting modified road tar specifications and thus modifying distillation policy, it was suggested by, among others, the writer of this note, that the authorities using road tar be approached for their co-operation.

In the earlier stages of discussion it was claimed in support of adherence by the Tar Producers' Association to present specifications that (*a*) there was very great demand for road tar on the part of the Public Works Department and that (*b*) the road making authorities adopted a somewhat uncompromising attitude to the matter of departure from present road making and road tar specification policy.

That point was investigated by the present writer personally in discussion with the highest authorities of the Public Works Department, the Railway Board and the Engineer-in-Chief and an entirely contrary attitude was met with, all authorities concerned expressing most freely their openness of mind in the matter. We may assume, therefore, with entire confidence that if it should be technically, if not economically, possible to treat our crude coal tar more scientifically and help to meet essential civil and military demands other than those met at present by the tar distilling industry, such modifications, as may be proposed and proved to be feasible (if only during war time) will be gladly accepted by the authorities. We may assume their whole hearted co-operation.

It would appear desirable, therefore, critically to examine the main road tar specifications at present applicable to tars used for road treatment in India, as well as road making specifications. It should be kept in mind that the climate of India is almost nowhere similar to that of Britain for which the British Standard Specifications were drawn up. A similar aspect of the matter was realised by American authorities when investigating this same problem, the continent of America, like that of India, persenting climatic conditions of widely diverse types. There is, therefore, a *prima facie* case for critical examination of this fundamental matter of specifications, preferably by actual experiment and with an entirely open mind.

SOFT COKE MANUFACTURE

The by-product that might be recovered in this industry are not in actual fact recovered, though proposals for their recovery put forward some years ago by the present writer after four years of investigation in the field are under consideration. The average temperature at which soft coke is made is seldom higher than 500°C.; consequently the tar that might be recovered would be found to be particularly suitable for extraction of some of the chemical substances in which the Basic Chemicals Committee has been interested. It is highly desirable that the proposals above referred to should be examined and large-scale experiments should be carried out. No early development can, however, be confidently expected.

THE PRODUCTS OF DISTILLATION OF COAL

As has been seen in examining the position in respect of the inter-trade relations, it is difficult to state with confidence what demands really exist for the various products either at present produced or potentially available in marketable quantities. Many manufacturers simply do not voice their demands, confident that under present conditions in India it is a waste of time to do so and they are, in consequence, importing from abroad manufactured articles and other intermediate raw materials whose manufacture or production has involved the production of those vary raw materials that could be produced in India in marketable quantities from her supplies of coal tar and from other coal by-products. Furthermore, the products of the by-product industry vary so greatly, from pure chemical to indefinite mixtures of great complexity known under names that inadvertently conceal (from the non-technical person) the actual composition, that attempts to compile statistics are at present futile. For purposes of reference, in order to give a more detailed picture of the importance of the various products obtainable from coal a selection of the important products, with a note about their properties and uses, is appended.

GENERAL

In the iron and steel industry most of the firms concerned are handling the same types of raw materials and engaged in the manufacture of the same type of primary products. There is normal healthy competition for business but the same broad principles govern policy. Certain firms concentrate, no doubt, on the manufacture of special ranges of products but beyond that the organisation of one iron works or one steel works is much the same as that of any other. By contrast, the constituent members of the by-product coking, gas-making and tar distillation industries compete among themselves for their own intermediate products and are interested in making materials of widely differing nature, in the making of which the treatments given to the raw materials, or the intermediates used as such, also vary greatly.

Accordingly control is not simply a matter of allocating business in fair proportions but is a technical matter requiring scientific knowledge of a high degree accompanied by a knowledge of the trade ramifications.

Notes on individual by-products

Benzene.—A simple chemical compound. " Benzol " and " Benzole " are names commonly given to a mixture of benzene and toluene (q.v.) commonly obtained as a fairly pure redistillation by-product, " benzole " being the spelling now officially approved in Britain. In certain countries " benzol " is the name approved in scientific circles for what is in Britain called " benzene."

Formerly extensively (and still to some extent) used as a motor fuel, either as the mixture referred to above or mixed with petrol (e.g. " National Benzole Mixture "), it is now commonly re-distilled and the two main constituents Benzene and Toluene separated.

Essential Civil requirements stated to be 6,500 tons (16,72,000 gallons approx.) and War Department requirements to be 700 tons (1,80,000 gallons). But the War Department can take any amount of benzene, upto millions of gallons per month and the above figure is no doubt merely what was available after allowing for essential civil needs.

Benzene and toluene are recovered mainly from coal gas and not, as is commonly supposed, mainly from coal tar, though the lighter fractions of redistillation of tar do give some of both of those compounds. Benzole is at present recovered only from the following plants in India : Bararee Coke, Giridih, Tata's coke plant, Indian Iron and Steel Co., (in course of erection or perhaps now started). No benzole is recovered from the plants at Loyabad, Lodna and Bhowra.

Including what is being or will shortly be recovered by the Indian Iron and Steel Co., the total annual production comes to 1,664,000 gallons per year (6,420 tons) and when the Tata plant is developed, as is expected, that figure will rise to 2,066,000 gallons (7,960 tons). (Statistics have not in all cases clearly distinguished between benzene and benzole). The production from Bararee is about 70,000 gallons per year (toluene-free benzene). The Giridih plant is stated to recover benzole for further treatment at the Tata plant, the amount being 50,000 gallons per year.

It is understood that there are proposals to install recovery plants at Bhowra, Lodna and Loyabad. Apart from its value as an " anti-knock " internal combustion engine fuel, benzene is an extremely valuable "primary" chemical from which thousands of important chemical substances can be prepared. There is a generally-held idea that aniline. the starting-point in the manufacture of a very large range of dyes, is found in coal tar. Aniline is manufactured from nitrobenzene which is manufactured from benzene, so that that substance, benzene, is really the starting-point in the long chain of operations in the manufacture of aniline dyes. It is also the raw material from which are manufactured thousands of other chemical substances including phenol (carbolic acid) and, of course, *its* derivatives, nitrobenzene, aniline (from which dyes, drugs, explosives and photographic developers, sulphanilic acid, acetanilide, antipyrine), etc.

Before the present war Government's excise policy relating to the use of benzole as a motor fuel made it entirely unprofitable to extract and sell the benzole in the open market. The excise duty made it impossible for the coke industry to compete with the petroleum industry. There is little doubt that after the present war it will again be economically unprofitable to extract benzole for use as a motor fuel unless there is a complete change of excise policy, but there will be an increasing demand for benzene (and for toluene) for chemical purposes. (See also remarks below regarding PHENOL). There can, therefore, be no doubt that complete recovery in the course should be aimed at.

TOLUENE.—Before the present war small quantities of toluene were imported for chemica purposes. There is no information about the amount, if any, imported for the manufacture of explosives. Supplies for chemical purposes were to a large extent met from Germany. But large quantities of substances manufactured from toluene were imported (again largely from Germany) and as Indian industry develops there will be an increasing demand. As will be seen from the preceding note on Benzene, the demand for and the supply of toluene depend to a great extent upon the extraction of benzole from gas and tar and the production of pure benzene. The amount available is generally of the order of one-tenth to one-fifth of the total crude benzole. It is required for the manufacture of the high explosive "T.N.T." and is also the starting-point in the manufacture of an enormous number of chemical substances (e.g., benzaldehyde, saccharin, synthetic perfumes and essences and many dyes) nearly all of which are imported into India. Even in peace time, therefore, there will be a great demand for toluene.

PHENOL (Carbolic acid), CRESOL, "TAR ACIDS" :—The normal civil demand for this important antiseptic and disinfectant is stated to be 400 tons. It is very doubtful whether any attempt should be made to cut down this demand if local supply is available. On the contrary the War Department requirements are shown as 100 tons ; but this figure relates to "Phenols" and "Cresols". These "tar acids" really provide several urgently required separate constituents, phenol, cresylic acid, etc. There is a substantial demand for phenol for treatment of lubricating oil; the Attock Oil Company are stated to be buying synthetic phenol from Australia. No synthetic phenol is being made at present in India. Phenol not only occurs in coal tar but can be chemically manufactured from benzene. (It should be made clear that synthetic phenol is exactly the same substance as phenol obtained from tar, and is not in any sense a substitue.) Phenol is one of the two main raw materials from which the large range of "phenol-formaldehyde" resins or plastics are made and a vast industry awaits development in India. At one meeting of the Basic Chemicals Committee the conclusion was arrived at that 175 tons of phenol per annum could be easily absorbed in the early stages of establishing the industry. That figure would increase very rapidly.

Phenol is also one of the raw materials for the manufacture of many chemicals and drugs, e.g., salicylic acid, aspirin, phenacetin, picric acid and dyes, and many of those substances are comparatively easy to manufacture. The leather industry in India at present requires up to 400 tons for "leather oils" and there is a similar demand for these tar acids for "cutting oils". It is unnecessary to separate the civil demand from that for the War Department. It is clear that at least 1,200 tons of separate tar acids could be absorbed immediately, if available, and there will be a steady post-war demand. Here again we see that maximum possible recovery can be advocated. But there is a countervailing aspect that has next to be considered, namely the demands for creosote and road tar.

The demand for pure phenol for the Medical Services is firm and urgent. It is understood that a tar distillation plant is being imported specially for this purpose and that it will handle 10 tons of coal tar per day. The tar produced by the coke plants at Giridih and Bhowra will almost certainly be required for this purpose alone.

CREOSOTE.—Creosote is the name loosely given to a major "fraction" of the products of distillation of tar. It is a complex mixture containing the bulk of the above tar acids. Without further treatment it is invaluable as a wood preservative, and the War Department demand alone is shown as 14,000 tons, to which are to be added the civil requirements of 1,700 tons.

Wood tar creosote is also used for this purpose but in India it is somewhat uncertain. It is or can be mainly produced in South India.

Road Tar.—Road tars are of various grades, from No. 1 to 3A, and so classified mainly according to the viscosity. Their production necessitates the dehydration of the tar and the removal of a less or greater proportion of the lighter distillation products and other constituents, e.g., benzole, naphthalene, etc., and in some cases a proportion of the lighter creosote oils. In the preparation of the most viscous tars (if these are produced by simple distillation as distinct from blending) an appreciable proportion of the creosote oils may be removed and recovered. Very skilled blending of tars and distillation products of tar is required in order to produce road tars complying with the various standard specifications.

According to the various processes which the crude tars are submitted to produce road tars, naphthalene or a substantial proportion of the naphthalene may in some instances remain in the road tar. This is more likely to be the case when less viscous tars are produced unless these are produced by thinning down the more viscous tars (or pitch) with thinner naphthalene-free tars.

SUMMARY AND CONCLUSIONS

1. The by-product coking and gas-making industries in India are capable of adjustment and development to meet urgent war demands of a nature that they have not hitherto been called upon to supply.

2. The majority of these are present firm demands that will either remain or be replaced by equivalent post-war demands.

3. These post-war demands will tend to increase.

4. The coal tar distillation industry is at present very largely concerned with the manufacture of road tar and creosotes. That section of the industry that deals more particularly with the extraction of tar acids, naphthalene, etc., produces large quantities of pitch for which there is not at present a sufficiently large demand.

5. The tars from certain coke plants and gas companies are specially rich in tar acids and other constituents of special value for chemical purposes. These companies are concerned in the production of about 1/10th of the total tar output.

6. A substantial proportion of disinfectant fluids at present marketed are of little or no value as disinfectants. It is recommended that action (legislative if necessary) be taken to discontinue the indiscriminate use of tar products as disinfectant fluids.

7. A number of basic chemical substances not at present made in India to meet present demand could be made from coal by-products.

8. It is recommended that the adoption be encouraged of a general policy of more exhaustive distillation of coal tar, from the point of view of the chemical industry as distinct from that of the road tar industry but with due regard to the fundamental needs of the latter.

APPENDIX XVIII

A NOTE BY Dr. SIR SHANTI SWARUP BHATNAGAR ON CRUDE COAL TAR.

The figure mentioned in Appendix XVIII of the Pai-Venkataraman Report for yearly production of coal tar (19,200 tons) represents figures reported to the Chairman of the Dyestuffs Exploratory Committee in answer to the questionnaire issued by him to tar distillers. It has, however, been stated on page 38a of the Pai-Venkataraman Report that the total production of coal tar in India has been estimated to be about 100,000 tons (B. W. Haigh, Transactions of the Mining, Geological and Metallurgical Institute of India, 1939-40, **35**, 365). The details of the actual production of coal tar in India at the present time are as follows, as compiled for the Basic Chemicals Committee of the Supply Development Committee.

Company or Managing Agents	Location of Plant.	Monthly Production of Coal Tar.
Metallurgical Coke Plants.		
The Tata Iron and Steel Co.	Jamshedpur	3,700 tons.
The Indian Iron and Steel Co.	Hirapur (R)	1,500 ,,
	Kulti (R)	600 ,,
Bird and Co., The Barakar Coal Co.	Loyabad (J)	200 ,,
Jardine, Skinner &Co.	..	..
Bararee Coke Company	Kusunda (J)	200 tons.
Mackinnon Mackenzie & Co.	Bhowra (J)	200 ..
Turner Morrison & Co.	..	..
Lodna Collieries Co. (1920)	Lodna (J)	150 tons.
State Railway Collieries	Giridih (G)	75 ..
Monthly Total		6,625 ..

R = Raniganj Coalfields. J = Jharia Coalfield. G = Giridhi Coalfields.

TOTAL ANNUAL PRODUCTION

Tar from metallurgical coke plants	79,500 tons per annum.

GAS PLANTS

	Monthly production.
The Oriental Gas Company Ltd., Calcutta (stated to be 200 to 260).	360
The Bombay Gas Company Ltd., Bombay	150 approximately
	410 tons.

Total annual production from Gas Companies	4,900 tons.
GRAND TOTAL OF ANNUAL PRODUCTION OF COAL TAR	= 84,400 tons.

(Less 5 per cent. moisture.)

In addition to these tar producing agencies in India there are other industrial undertakings concerned in the subsequent treatment of coal tar. These latter include :—

The Shalimar Tar Products, Calcutta and Lodna ;

Bengal Chemical and Pharmaceutical Works, Ltd., Calcutta ;

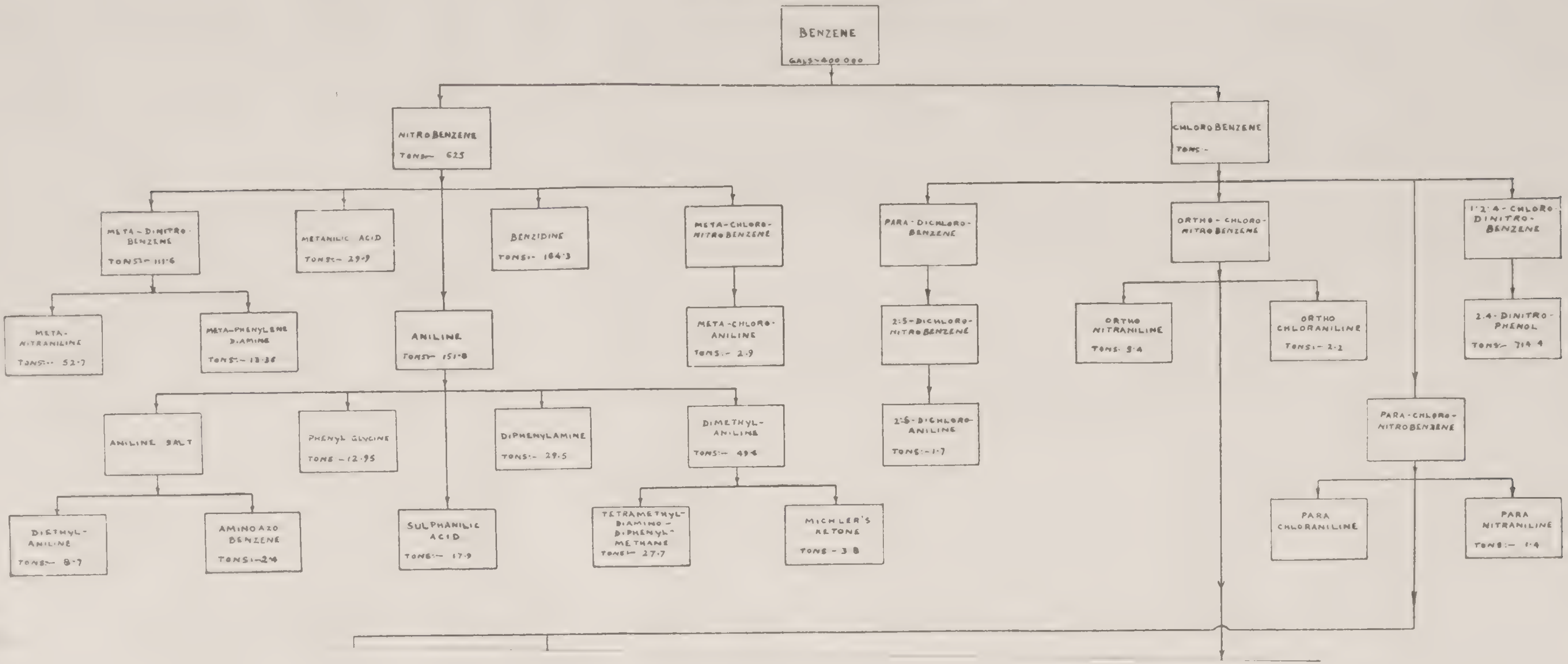
Behar Chemical Traders, Howrah (near Calcutta) ; and

The Bararee Coke Company above referred to also distil a considerable proportion of their tar.

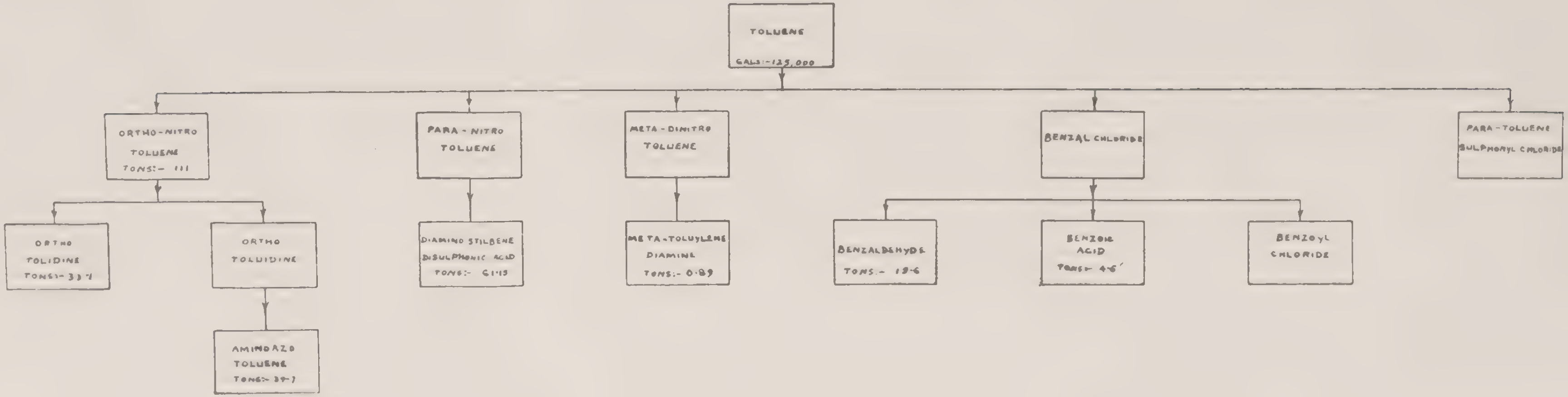
Flow sheets Nos. 1-8:
see page 13 of the Report.

①

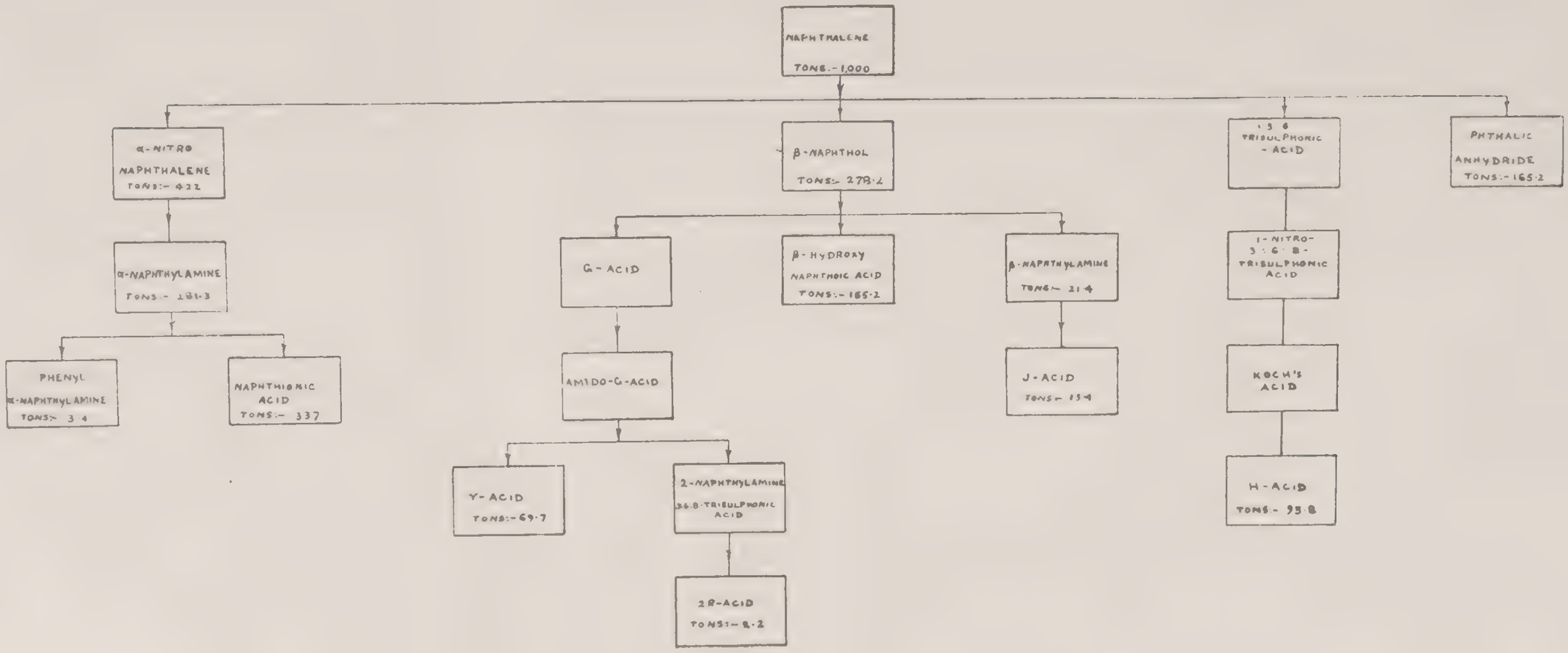
INTERMEDIATES FROM BENZENE AND PHENOL



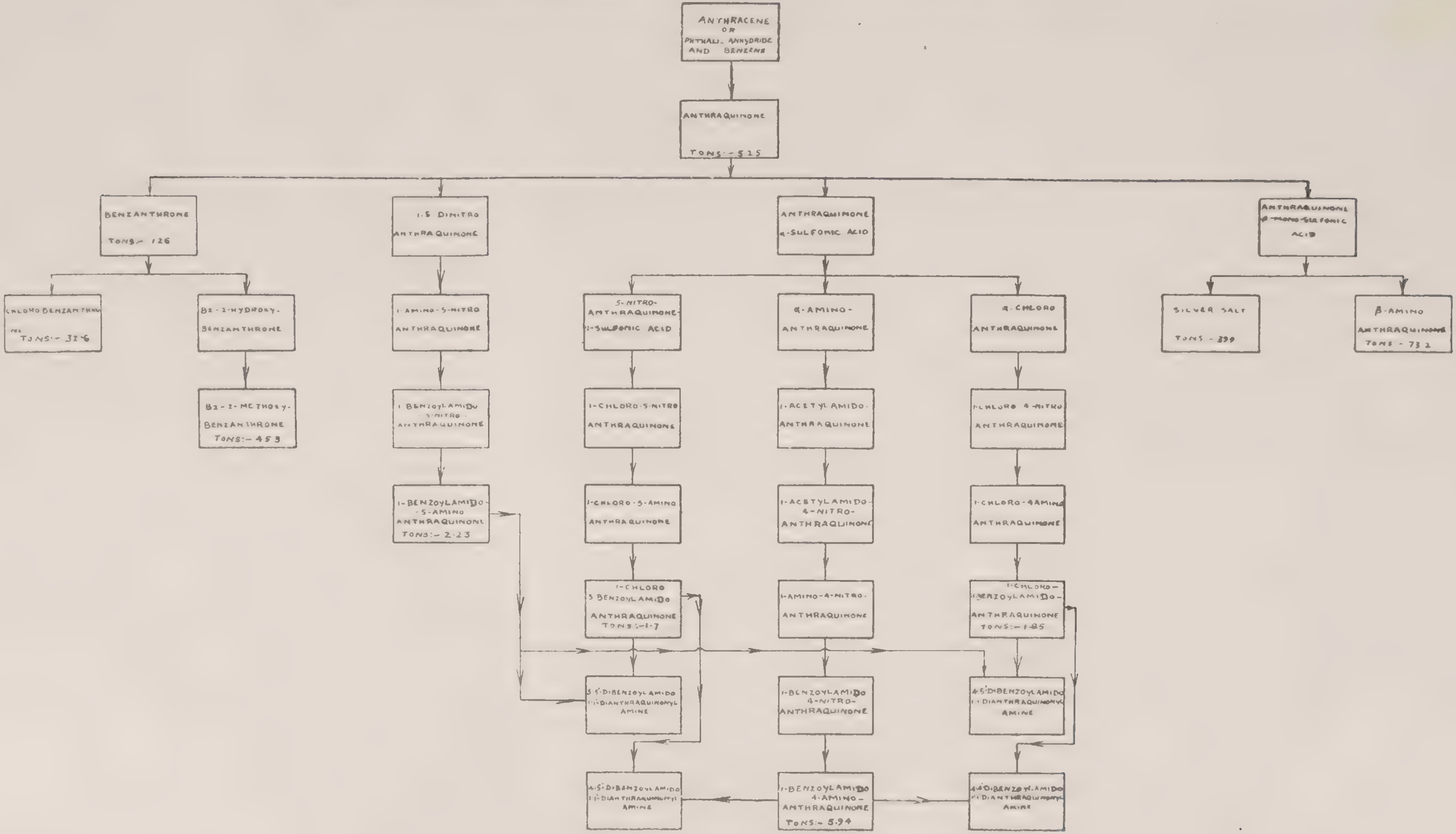
INTERMEDIATES FROM TOLUENE



INTERMEDIATES FROM NAPHTHALENE



INTERMEDIATES FROM ANTHRAQUINONE


ANTHRACENE OR PHTHAL. ANHYDRIDE AND BENZENE
ANTHRAQUINONE TONS:-525
BENZANTHRONE TONS:- 126
CHLORO BENZANTHRONE TONS:- 32·6
Bz-2-HYDROXY-BENZANTHRONE
Bz-2-METHOXY-BENZANTHRONE TONS:- 453
1.5 DINITRO ANTHRAQUINONE
1-AMINO-5-NITRO ANTHRAQUINONE
1 BENZOYLAMIDO-5-NITRO-ANTHRAQUINONE
1-BENZOYLAMIDO-5-AMINO ANTHRAQUINONE TONS:- 2·23
ANTHRAQUINONE α-SULFONIC ACID
5-NITRO-ANTHRAQUINONE-1-SULFONIC ACID
1-CHLORO-5-NITRO ANTHRAQUINONE
1-CHLORO-5-AMINO ANTHRAQUINONE
1-CHLORO 5 BENZOYLAMIDO ANTHRAQUINONE TONS:-1·7
5.5'-DIBENZOYLAMIDO 1.1'-DIANTHRAQUINONYL AMINE
4.5'-DIBENZOYLAMIDO 1.1'-DIANTHRAQUINONYL AMINE
α-AMINO-ANTHRAQUINONE
1-ACETYLAMIDO-ANTHRAQUINONE
1-ACETYLAMIDO-4-NITRO-ANTHRAQUINONE
1-AMINO-4-NITRO-ANTHRAQUINONE
1-BENZOYLAMIDO 4-NITRO-ANTHRAQUINONE
1-BENZOYLAMIDO 4-AMINO-ANTHRAQUINONE TONS:- 5·94
α-CHLORO ANTHRAQUINONE
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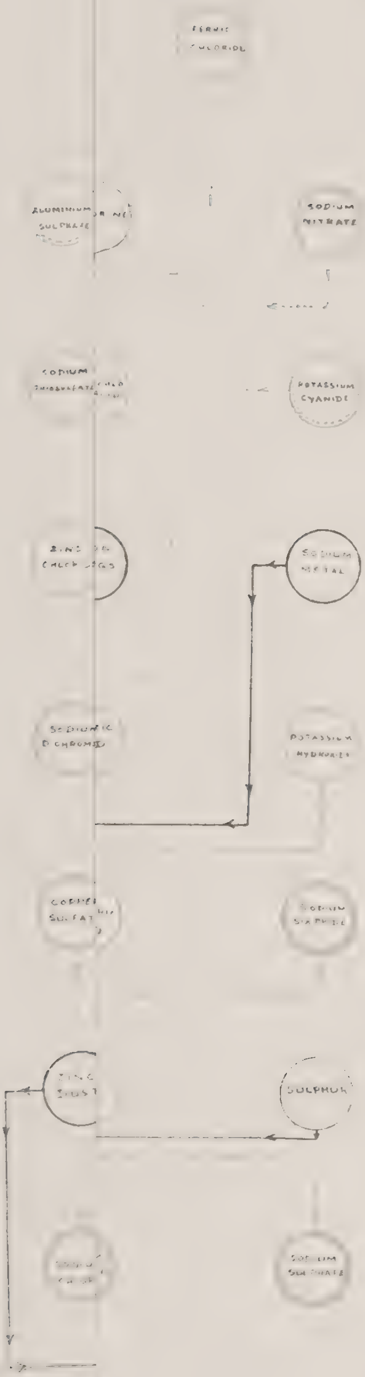

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